[Claims]

[Claim 1]

An energy-saving control method of an air conditioner in a game hall of connecting in series rotary total heat exchangers for performing energy-saving operation on air conditioning to the air conditioner in the game hall so as to perform the energy-saving operation of the air conditioner from startup operation to air-conditioning operation, characterized in that:

the startup operation is performed by operating an indoor device of the air conditioner in an unventilated state, setting up cooling or heating operation by comparing a return air temperature with an indoor preset temperature and then automatically operating an outdoor device;

the air-conditioning operation is performed by taking in outside air after completing the startup operation of the air conditioner, setting up the cooling or heating operation by comparing the outside air temperature with a predetermined cooling and heating switching preset temperature and then automatically operating until the return air temperature becomes the indoor preset temperature;

rated operation of the total heat exchangers is performed in the case where outside air enthalpy is higher than the return air enthalpy during the cooling operation of the air conditioner, speed control operation of the total heat exchangers is performed in the case where the outside air enthalpy is lower than the return air enthalpy during the cooling operation of the air conditioner or during the heating operation of the air conditioner and the total heat exchangers are thereby automatically operated so as to collect heat according to a value having an offset value added to or subtracted from the indoor preset temperature; and

the entire circulating flow volume is passed through a coil during the automatic operation of the total heat exchangers and in the case where return air humidity during the cooling operation of the air conditioner is lower than the preset humidity and during the heating operation of the air conditioner, the coil passing flow volume of the circulating flow volume is limited in the case where the return humidity during the cooling operation of the air conditioner is higher than the preset humidity, and the rated operation of the total heat exchangers is performed to limit inflow of moisture only in the case where the coil passing flow volume is being limited and the return absolute humidity during speed control operation of the total heat exchangers is lower than the absolute outside air humidity.

[Detailed Description of the Invention]

[0001]

[Industrial Application field]

The present invention relates to an energy-saving control method of an air conditioner in a game hall such as a pachinko parlor.

[0002]

[Conventional Art]

As for conventional air conditioners in a game hall such as a pachinko parlor, there are adopted methods such as a distributed cassette system of implanting cassette-type air conditioners and air cleaners into a ceiling in the hall in an appropriately dispersed manner and a central method of installing a floor-type large air conditioner, an electric dust collector, a fan and the like in a machine room and sending conditioned air to the hall via a duct.

[0003]

[Problems to be Solved by the Invention]

Regarding the conventional distributed cassette system, however, there are many cases where exhaust ventilation is performed by a ventilator. In this case, heat recovery from exhaust is equal to zero. Therefore, air conditioning has to be performed only with the air conditioners and ventilators in the game hall such as a pachinko parlor having a large heat load all the time. Thus, there has been a problem that control over temperature and humidity for satisfying comfort cannot be efficiently exerted and running costs become extremely high.

[0004]

The central method similarly has a problem that control must be exerted over the temperature and humidity only with the air conditioner by taking in a lot of outside air to satisfy comfort and use of the air conditioner is required even in an interim period for instance so that the running costs become high. There is also a problem that selection of cooling and heating becomes subtle in the interim period and so operation is performed by switching between cooling and the heating during one day, which is not desirable to equipment such as the air conditioner. The present invention has been made in order to solve such conventional problems, and an object thereof is to provide a control method that can render the air conditioning in a game hall such as a pachinko parlor having a large heat load energy-saving by controlling ventilation and efficiently using total heat exchangers.

[0005]

[Means for Solving the Problems]

The present invention provides as a means for attaining the object an energy-saving control method of an air conditioner in a game hall such as a pachinko parlor of connecting in series rotary total heat exchangers for performing energy-saving operation on air conditioning to the air conditioner in the game

hall so as to perform the energy-saving operation of the air conditioner from startup operation to air-conditioning operation, characterized in that: the startup operation is performed by operating an indoor device of the air conditioner in an unventilated state, setting up cooling or heating operation by comparing return air temperature with preset temperature and then automatically operating an outdoor device; the air-conditioning operation is performed by taking in outside air after completing the startup operation of the air conditioner, setting up the cooling or heating operation by comparing the outside air temperature with a predetermined cooling and heating switching preset temperature and then automatically operating until the return air temperature becomes the indoor preset temperature; rated operation of the total heat exchangers is performed in the case where the outside air enthalpy is higher than the return air enthalpy during the cooling operation of the air conditioner, speed control operation of the total heat exchangers is performed in the case where the outside air enthalpy is lower than the return air enthalpy during the cooling operation of the air conditioner or during heating operation of the air conditioner and the total heat exchangers are thereby automatically operated so as to collect heat according to a value having an offset value added to or subtracted from the indoor preset temperature; and entire circulating flow volume is passed through a coil during the automatic operation of the total heat exchangers and in the case where return air humidity during the cooling operation of the air conditioner is lower than preset humidity and during the heating operation of the air conditioner, coil passing flow volume of the circulating flow volume is limited in the case where the return humidity during the cooling operation of the air conditioner is higher than the preset humidity, and the

rated operation of the total heat exchangers is performed to limit inflow of moisture only in the case where the coil passing flow volume is being limited and the absolute return humidity during speed control operation of the total heat exchangers is lower than the absolute outside air humidity.

[0006]

[Operation]

The startup operation of the air conditioner is performed until the temperature of return air becomes the predetermined indoor preset temperature, and the outside air is taken in after completing the startup operation so as to perform the air-conditioning operation by switching between the cooling operation and the heating operation depending on the state of the outside air temperature. In this case, the cooling operation is performed by targeting the indoor preset temperature in the case where the outside air temperature is higher than the predetermined cooling and heating switching preset temperature or the heating operation is performed by targeting the indoor preset temperature in the case where the outside air temperature is lower than the cooling and heating switching preset temperature.

[0007]

A comparison is made between the return air enthalpy and the outside air enthalpy during the air-conditioning operation, and the total heat exchangers are operated at rated speed in the case where the return air enthalpy is lower than the outside air enthalpy during the cooling operation of the air conditioner. In the case where the return air enthalpy is higher than the outside air enthalpy during the cooling operation of the air conditioner, heat recovery operation is performed under speed control by setting the total heat exchangers at temperature a little lower than the cooling and heating switching preset

temperature. During the heating operation of the air conditioner, the heat recovery operation is performed under speed control by setting the total heat exchangers at temperature a little higher than the cooling and heating switching preset temperature. Thus, efficient temperature control is performed.

[0008]

Thus, the return air and the outside air are compared in terms of enthalpy, and the air-conditioning operation is performed based on the preset temperature. A comparison is made between the return air humidity and the preset humidity during the air-conditioning operation. In the case where the return air humidity is lower than the preset humidity during the cooling operation of the air conditioner or during the heating operation, the entire circulating flow volume is passed through a coil for cooling the air-conditioner. In the case where the return air humidity is higher than the preset humidity during the cooling operation of the air conditioner, coil passing flow volume is limited after securing the circulating flow volume so as to more efficiently eliminate moisture.

[0009]

In the case where absolute humidity of the return air becomes lower than the absolute humidity of the outside air during limited speed operation of the total heat exchangers while the coil passing flow volume is limited, the rated operation of the total heat exchanger is performed and the inflow of the moisture is thereby limited so as to efficiently adjust the humidity.

[0010]

As previously described, it is possible, by comparing the enthalpy and the absolute humidity, and exerting cooling and heating switching control over the total heat exchangers based on the comparison, to perform temperature adjustment and

humidity adjustment so as to attain energy saving with the game hall such as a pachinko parlor having a large heat load air-conditioned in a comfortable state.

[0011]

[Embodiment]

Hereafter, an embodiment of the present invention is described in detail based on the drawings. Figure 1 is an explanatory diagram showing an air conditioner of this embodiment. First, a configuration thereof will be described based on Figure 1. An air conditioner A of this embodiment includes a package 1, an electric dust collector 2, a mixing box 3, an inlet chamber 4, an exhaust chamber 5 and a rotary total heat exchanger 6 in this order.

[0012]

The package 1 includes a direct cooling coil 1a and an air sending fan 1b while the direct cooling coil 1a communicates with the electric dust collector 2 via a branching box 1c, and the air sending fan 1b communicates with a game hall (not shown) via a duct 1d. The branching box 1c and the package 1 also directly communicate with a duct 1e which bypasses the direct cooling coil 1a. And the ducts 1d and 1e are provided with motor dampers MD_S and MD_B respectively. The package 1 is provided as an indoor device, and multiple outdoor devices 1f (two in the embodiment) are provided to the package 1.

[0013]

The inlet chamber 4 includes an intake fan 4b for taking in outside air via an outside air intake duct 4a and sending it to the mixing chamber 3. And the outside air intake duct 4a is provided with a motor damper MD_4, an outside air temperature detector 4c and an outside air humidity detector 4d.

[0014]

The exhaust chamber 5 is provided in an upper part of the inlet chamber 4, and includes an exhaust duct 5a and an exhaust fan 5b, where a return duct 3a is branched and also connected with the mixing box 3. Reference character MD5 in Figure 1 denotes a motor damper on the exhaust chamber branch side, and MD3 denotes a motor damper on the mixing box side. Reference character 3b denotes a return air temperature detector provided to the return duct 3a, and 3c denotes a return air humidity detector.

[0015]

The total heat exchanger 6 is a rotary type and provided with an inverter (not shown) for exerting speed control. The total heat exchanger 6 is placed in a middle portion between the inlet chamber 4 and the exhaust chamber 5, and is provided so that an air supply side 6a of a rotor communicates with the front and rear of the inlet chamber 4 and an exhaust side 6b communicates with the front and rear of the exhaust chamber 5. Reference character 6c and 6d denote filters.

[0016]

This embodiment includes a control portion for arbitrarily actuating the air sending fan 1b, the intake fan 4b, the exhaust fan 5b, the motor dampers MD_B, MD_S, MD3 to MD5 and the like on a central monitoring panel (not shown). This embodiment includes a calculator connected to the control portion, which performs cooling and healing judgment, enthalpy comparison, absolute humidity comparison and the like by calculating return enthalpy i_R, absolute humidity X_R, outside air enthalpy i_O, absolute humidity X_O and the like with detected data of the outside air temperature detector 4c, the outside air humidity detector 4d, the return air temperature detector 3b, the return air humidity detector 3c and the like.

[0017]

The air conditioner A of this embodiment performs startup operation by switching between the cooling and the heating of the package 1 until a preset time or predetermined indoor preset temperature is met according to a temperature state of the return air. After finishing the startup operation, the cooling and healing judgment is made according to the state of outside air temperature so as to perform the cooling operation or the heating operation. And during the cooling operation, the air conditioner A compares the outside air enthalpy with the return air enthalpy, and exerts the speed control (rated or decelerated operation) of the total heat exchanger including the case of the heating operation. The moisture is eliminated according to the state of the return humidity during the operation of the total heat exchanger 6.

[0018]

Next, automatic cooling and heating switching, interim period control and humidity control of the embodiment will be described based on flowcharts shown in Figures 2 and 3. First, operation or stop of the air conditioner A is selected (step 101). In the case of stop, the package 1, the outdoor devices 1f, the electric dust collector 2, the intake fan 4b, the exhaust fan 5b and the total heat exchanger 6 are put in the stop state (step 102), and further the motor dampers MD_B, MD4 and MD5 become fully closed and the motor dampers MD_S and MD3 are put in fully open state (step 103). In the case of operation, as shown in Figure 6, the package 1 and the electric dust collector 2 are operated, and the return air is circulated to and from the hall via the return duct 3a and the duct 1d (step 104). Return air temperature T_R at the time is measured by the return temperature detector 3b and read into the calculator together with the indoor preset temperature S_P (step 105).

[0019]

A comparison is made between the return air temperature T_R and the indoor preset temperature S_P (at approximately 24°C but variable at the pachinko parlor). It is thereby judged whether to perform the cooling or the heating (step 106), and a warming-up timer is actuated (step 107). And in the case where the return air temperature T_R is larger than the indoor preset temperature S_P as the startup operation, the outdoor devices 1f are put in the cooling operation (step 108). If smaller, the outdoor devices 1f are put in the heating operation (step 109). In this case, when in the cooling operation, the outdoor devices 1f are operated until the return air temperature T_R becomes a little lower than the indoor preset temperature S_P as shown in Figure 4. And when in the heating operation, as shown in Figure 5, the outdoor devices 1f are operated until the return air temperature T_R becomes a little higher than the indoor preset temperature S_P or the warming-up timer indicates that time is up.
[0020]

In the startup operation, after the return air temperature T_R and the indoor preset temperature S_P become equal or after the warming-up timer indicates that time is up, the intake fan 4b and the exhaust fan 5b are operated, the motor dampers MD4 and MD5 are opened and the motor damper MD3 is put in a half-open state (step 110). And thereafter, the return air temperature T_R and humidity H_R, outside air temperature T_O and humidity H_O are measured (step 111). The return air enthalpy i_R, the absolute humidity X_R, the outside air enthalpy i_O and the absolute humidity X_O are calculated based on the data (step 112).
[0021]

Next, a comparison is made first between the predetermined cooling and heating switching preset temperature T_{SS} (at approximately 10°C, but variable at the pachinko parlor) and the outside air temperature T_O so as to perform cooling and healing

judgment of the air conditioning yet to be performed (step 113). In the case where the outside air temperature T_O is smaller than the predetermined cooling and heating switching preset temperature T_{SS}, the operation is switched to the heating operation (step 114). In the case where the outside air temperature T_O is larger than the predetermined cooling and heating switching preset temperature T_{SS}, the operation is switched to the cooling operation (step 115). First, in the case of the heating operation, as shown in Figure 7 (a), the total heat exchanger 6 is operated under the speed control by providing a positive offset of 1 to 2 degrees to the indoor preset temperature S_P (step 116). Only in the case where the return air temperature T_R is smaller than the indoor preset temperature S_P in the comparison between the return air temperature T_R and the indoor preset temperature S_P (step 117), the outdoor devices 1f are operated (step 118). In the case of the cooling operation, a comparison is made between the return enthalpy i_R and the outside air enthalpy i_O (step 119), and the rated operation of the total heat exchanger 6 is performed when the return enthalpy i_R is smaller than the outside air enthalpy i_O (step 120). In the case where the return enthalpy i_R is larger than the outside air enthalpy i_O, as shown in Figure 7 (b), the total heat exchanger 6 is placed under the speed control to a temperature range where a negative offset value of 1 to 2 degrees is provided to the indoor preset temperature S_P (step 121). And in this state, only in the case where the return air temperature T_R is larger than the indoor preset temperature S_P in the comparison between the return air temperature T_R and the indoor preset temperature S_P (step 122), the outdoor devices 1f are operated (step 123). In Figures 7 (a) and (b), reference characters S_{PH} and S_{PC} denote indoor preset temperature, and H_{EX} denotes a heat recovery amount of the total heat exchanger 6.

[0022]

And a comparison is made between the return air humidity H_R and preset humidity H_{SP} (step 124) during the operation indicated in the step 123. In the case where the return air humidity H_R is smaller than the preset humidity H_{SP} or during the operation indicated by the step 118, the motor damper MD_B is fully closed and the motor damper MD_S is fully opened (step 125) so as to pass the entire circulating flow volume through the direct cooling coil 1a as shown in Figure 8. In the case where the return air humidity H_R is larger than the preset humidity H_{SP}, the motor damper MD_B is opened and the motor damper MD_S is put in the half-open state (step 126). At the time, a comparison is made between the return air absolute humidity X_R and the outside air absolute humidity X_O (step 127). Only in the case where the return air absolute humidity X_R is smaller than the outside air absolute humidity X_O, the rated operation of the total heat exchanger 6 is performed (step 128).

[0023]

As described above, the air conditioner A of this embodiment performs the startup operation in an unventilated state and requires no wasteful energy so as to be helpful to energy saving. And the cooling and heating switching judgment in step 113 is made by comparing the predetermined cooling and heating switching preset temperature T_{SS} (variable) with the outside air temperature T_O so that the number of times of switching becomes small and the operation becomes stable. In the interim period, as shown in Figure 9, a period K capable of performing comfortable air conditioning just by operating the total heat exchanger is extended so as to be helpful to the energy saving. In dehumidifying operation, as shown in step 126, the moisture can be efficiently eliminated by securing the circulating flow volume and limiting the coil passing flow volume. In addition,

no wasteful energy is required due to the control of the total heat exchanger, and comfortable air conditioning can be performed.

[0024]

As above, the embodiment of the present invention has been described. However, the concrete configuration of the present invention is not limited to the embodiment. Design changes and the like without departing from the scope of the present invention are included in the present invention.

[0025]

[Advantages of the Invention]

As described above, the energy-saving control method of the air conditioner in the game hall of the present invention has adopted the aforementioned method so that the startup operation is performed in the unventilated state and so energy-saving operation can be performed requiring no wasteful energy. And the cooling and heating switching judgment on performing the air conditioning is made by comparing the predetermined cooling and heating switching preset temperature with the outside air temperature so that the number of times of switching becomes small and the operation becomes stable. In the interim period, the period capable of performing comfortable air conditioning just by operating the total heat exchanger is extended so that the comfort is not affected and energy-saving operation can be performed. As some of the advantages of the invention, the coil passing flow volume is limited with the circulating flow volume secured, and so the comfort can be obtained by efficiently eliminating the moisture and also the energy-saving operation can be performed.

[Brief Description of the Drawings]

[Figure 1]

Figure 1 is an explanatory diagram showing an air conditioner according to an embodiment of the present invention.

[Figure 2]

Figure 2 is a flowchart showing control of the air conditioner of the embodiment.

[Figure 3]

Figure 3 is a flowchart showing the control of the air conditioner following parts B and C of the flowchart of Figure 2.

[Figure 4]

Figure 4 is an explanatory diagram showing on and off states in cooling operation of an outdoor device of the embodiment.

[Figure 5]

Figure 5 is an explanatory diagram showing the and off states in heating operation of the outdoor device of the embodiment.

[Figure 6]

Figure 6 is an explanatory diagram showing a startup operation state of the air conditioner of the embodiment.

[Figure 7]

Figures 7 are explanatory diagrams showing offset states of the outdoor device and a total heat exchanger in the heating operation and in the cooling operation of the embodiment in order of (a) and (b).

[Figure 8]

Figure 8 is an explanatory diagram showing a state of operation of the air conditioner of the embodiment, where entire circulating flow volume thereof is passed through a direct cooling coil.

[Figure 9]

Figure 9 is an explanatory diagram showing a state of operation of the total heat exchanger of the embodiment.

[Description of Symbols]

A Air conditioner

MD_B Motor damper provided to a duct for avoiding a direct cooling coil

MD_S Motor damper provided to a duct for sending air indoors

MD3 Motor damper provided to a duct for returning return air

MD4 Motor damper provided to a duct for taking in outside air

MD5 Motor damper provided to an exhaust duct

1 Package (indoor device)

6 Total heat exchanger

Figure 2

101 OPERATION OR STOP

102 STOP PACKAGE

STOP OUTDOOR DEVICES

STOP INTAKE AND EXHAUST FANS

STOP TOTAL HEAT EXCHANGER

STOP ELECTRIC DUST COLLECTOR

103 FULLY OPEN MD4 AND MD5

FULLY OPEN MD3

FULLY OPEN MD_B

FULLY OPEN MD_S

104 OPERATE PACKAGE

OPERATE ELECTRIC DUST COLLECTOR

105 MEASURE RETURN TEMPERATURE T_R

READ INDOOR PRESET TEMPERATURE S_P

107 WARMING-UP TIMER

108 COOLING OPERATION OF OUTDOOR DEVICES

109 HEATING OPERATION OF OUTDOOR DEVICES

110 OPERATE INTAKE FAN 4b

OPERATE EXHAUST FAN 5b

FULLY OPEN MD4 AND MD5

HALF OPEN MD3

111 MEASURE RETURN TEMPERATURE T_R

MEASURE RETURN HUMIDITY H_R

MEASURE OUTSIDE AIR TEMPERATURE T_O

MEASURE OUTSIDE AIR HUMIDITY H_O

112 CALCULATE RETURN ENTHALPY i_R

CALCULATE OUTSIDE AIR ENTHALPY i_O

CALCULATE RETURN ABSOLUTE HUMIDITY X_R

CALCULATE OUTSIDE AIR ABSOLUTE HUMIDITY X_O

Figure 3

114 HEATING

115 COOLING

116 CONTROL SPEED OF TOTAL HEAT EXCHANGER

118 OPERATE OUTDOOR DEVICES

120 RATED OPERATION OF TOTAL HEAT EXCHANGER

121 CONTROL SPEED OF TOTAL HEAT EXCHANGER

123 OPERATE OUTDOOR DEVICES

125 FULLY OPEN MD_B

FULLY OPEN MD_S

126 FULLY OPEN MD_B

HALF OPEN MD_S

128 RATED OPERATION OF TOTAL HEAT EXCHANGER

Figure 4

#1 ON AND OFF OF OUTDOOR DEVICES (COMPRESSORS)

Figure 5

#1 ON AND OFF OF OUTDOOR DEVICES (COMPRESSORS)

Figure 7

#1 SPEED OF ROTATION

#2 WHEN HEATING

#3 OUTDOOR DEVICES

#4 STOP

#5 OFFSET VALUE

#6 WHEN COOLING

Figure 9

#1 OUTER WALL LOAD CURVE

#2 HEATING OPERATION

#3 (PROVIDED WITH TWO TOTAL HEAT EXCHANGERS)

#4 ADJUST TEMPERATURE ONLY WITH TOTAL HEAT EXCHANGERS

#5 OUTSIDE AIR LOAD

#6 OUTSIDE AIR COOLING

#7 INDOOR LOAD

#8 COOLING LOAD

#9 HEATING LOAD

#10 TOTAL LOAD CURVE

#11 PACKAGE OPERATION
COOLING

#12 HEATING OPERATION
(PROVIDED WITH NO TOTAL HEAT EXCHANGER)